Units in 1954 that the discipline was formally recognized. Each E&WP Unit had an engineering geologist on the staff and the states added geologists to their staffs as the need dictated. The importance of their contribution became more generally acknowledged in all phases, i.e. preliminary examination, planning and operation. Handbook guidance for the procedures in making geological investigations and sampling for analysis was issued in 1963 and additional technical information on the description of materials and exploration methods and equipment was issued soon thereafter.

SCS engineering geologists actively participate in professional organizations establishing procedures for sampling sites proposed for earth dams and channels. Soil samples were forwarded to the Lincoln laboratory for testing and the preparation of recommendations pertaining to their intended use. As more and more data on soil materials were accumulated, the laboratory was able to develop helpful correlations to perfect the design process. Criteria for sampling underwent continuous evaluation and improvements were made reducing the cost of the site investigation and improving the quality of the data. The recommendations prepared for specific sites included a stability analysis for consideration by the design engineer.

Sedimentation Geology

Sedimentation studies have always been important to the work of the Soil Conservation Service, and from the very first, sedimentation geologists were attached to the technical staffs. Much of the knowledge of sedimentation as well as its application to the planning and operational phases of the SCS program was relatively new. The sedimentation geologist has the responsibility to determine the effects of sediment on SCS programs and conversely, the effect of SCS programs on the sediment yield.

Reservoir sedimentation surveys received much attention since they provided basic data. When analyzed, the information could be projected for estimates at other proposed impoundment sites. Early work by Henry M. Eakin and Carl B. Brown was important in establishing procedures, and during the period that SCS was authorized to conduct research, considerable attention was given to the further development of equipment and survey methods.

The advent of new programs of flood prevention and water resource development gave extra emphasis to the need for more refined estimates. Additional attention was given to the conduct of reservoir sedimentation surveys and the correlation of the results with the geologic, topographic, climatic, land use and vegetative characteristics of the watershed.

The Agricultural Research Service and U.S. Geological Survey have important responsibilities associated with sediment studies. The Corps of Engineers and the USDI Bureau of Reclamation also have interests in sedimentation processes and estimates. These and other federal Federal Inter-Agency Sedimentation Conferences provide valuable technical exchange.

SCS sedimentation geologists continue to associate information from measurement of erosion, suspended sediment loads, and the measurement of the volumes deposited in the reservoirs to improve their knowledge of sediment delivery ratios and trap efficiencies in reservoirs.

Another important function of the sedimentation geologist is the conduct of flood plain damage surveys. Here they utilize their knowledge of sediment properties and productivity and patterns of deposition to evaluate damages resulting from infertile deposition, swamping, scour, and effects on stream channels. Here again, the conduct of damage surveys provides a base for the development of procedures leading to continued refinements and precision.

Structural Engineering

Traditionally, engineers have had the responsibility for the design and construction of permanent structures. The functional requirements of conservation systems required the development of new types of structures with unique problems. Difficult site conditions often required special solutions. Insofar as possible, site investigations established the criteria for the design--often especially established for the individual structure. In other instances, standard plans were adequate when modified for size and capacity.

With the establishment of electronic communication and data transfer and the harnessing of the power of computers,

site conditions and made available to state and field offices. As the software programs

In 1965 President Johnson, with the strong supporting interest of Lady Bird

beneficial impact through the improvement of landscape features, i.e., improvement of cultivated areas, grasslands, and forests. The impacts on fish and wildlife by the improved coverand water impondments were also significant.

SCS engineers provided considerable data to the newly formed Environmental Protection Agency (EPA) when it was first

developed through contracts proposed and monitored by the SCS staff. Improvements in communications and data transmission capability between the design and field offices made the developments even more useful.

In 1984 the Engineering Division established the Engineering Software

DEVELOPMENT OF ENGINEERING APPLICATIONS FOR SCS PROGRAMS

Erosion Control

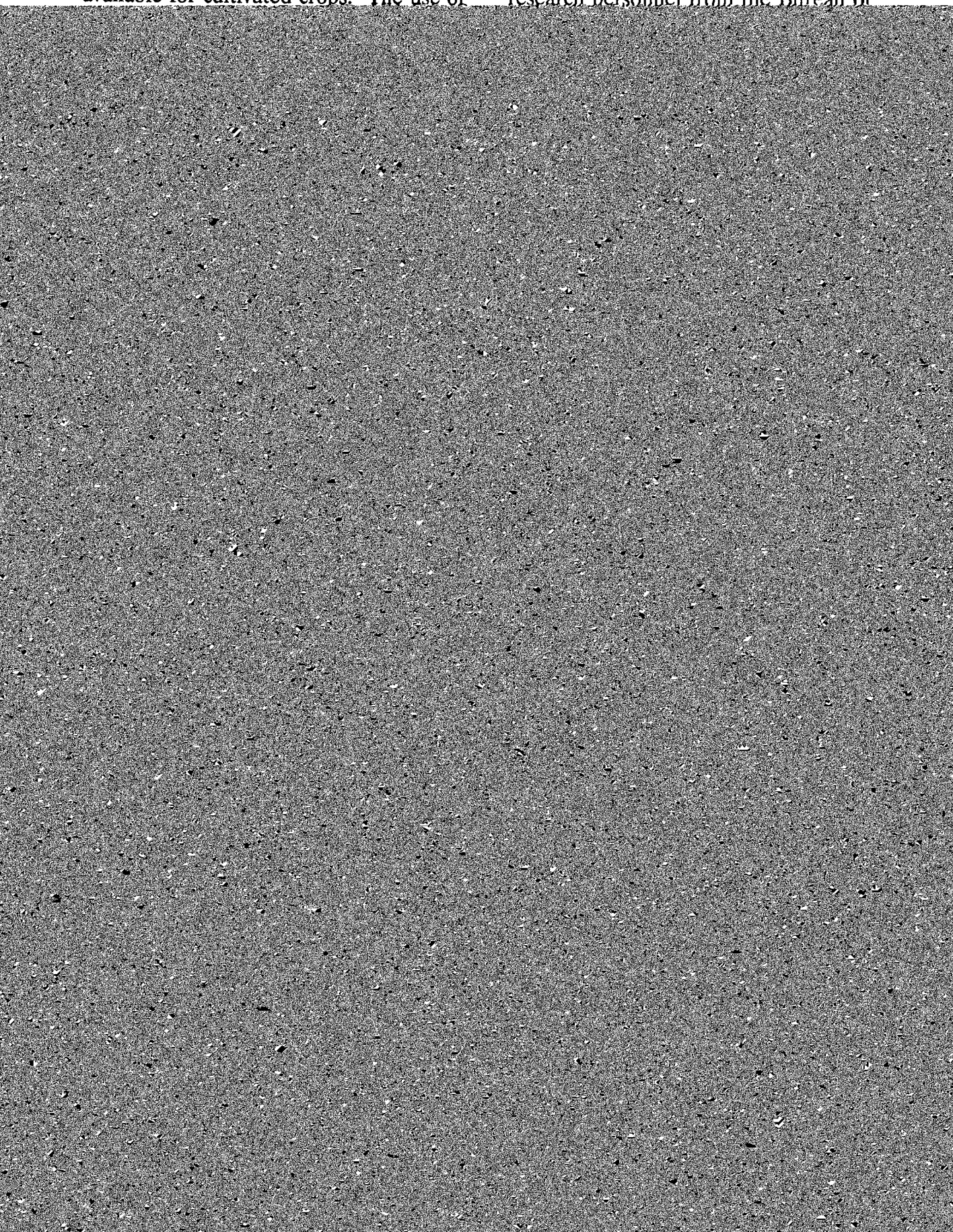
Soil erosion control was the first and principal interest of the newly organized Soil Conservation Service. Techniques for the installation of terraces and gully control devices were known to professionals, but even the need for such measures was not recognized by the general farm community

gave adequate protection. On these sites, engineering skills were needed for planning and layout.

Many farmers resisted terraces since the conventional measure of a good farmer was the straightness of his furrows. Farmers generally would first accept contour farming and later when they found that some reinforcement was needed, they accepted the need for terraces. Many still farmed with horses

As the size of farming equipment increased, there was more pressure to eliminate turnarounds and to utilize all the area available for cultivated crops. The use of

knowledge of irrigation methods. And in 1939, strong leadership in the technical field was provided by the transfer of research personnel from the Bureau of



Spartanburg, SC; Fort Worth, TX; Lincoln, NE; Albuquerque, NM; and Portland, OR. This was the first national meeting of any of the engineering specialists from the regions. The conference served to bring field problems to the attention of the research personnel and to establish the first tentative steps to prepare standards for irrigation practices. Later the Washington and regional irrigation engineers were

research on drainage problems. On June 25, 1935, the first CCC drainage camp was authorized and was administered by the BAE. During the next few months a total of 46 drainage camps were established in the southern and eastern states. These camps were authorized to rehabilitate main drainage canals serving districts or groups and provide adequate outlets for the private lands. No work

Flood Control and Soil and Water Resource Development

The Watershed Protection and Flood Prevention Act further expanded the engineering responsibilities and established the Soil Conservation Service as a major agency in the protection and development of small watersheds.

Suddenly, planning engineers were needed to conduct engineering preliminary examinations and meet with other professionals to prepare plans that met the objectives of the local sponsoring organization. Hydrologists and hydraulic engineers, geologists, sedimentationists, agricultural engineers, and others worked with other professionals in studying alternative approaches to the problems. Watershed plans had to be prepared which would permit evaluation by Congressional committees to authorize funds for construction.

These programs plus the river basin studies, flood hazard analysis, flood insurance studies, and the later organized Resource Conservation and Development (RC&D) program were administered by the Watershed Projects Division which had on their staffs a number of engineers to facilitate program operations. The detailed design and construction remained the responsibility of the Engineering Division.

Design engineers were involved with developing plans and specifications for complex structures of a size not previously constructed by SCS. Construction engineers carried greater responsibilities in inspection and documentation as well as involvement in safety and providing quantity of work data for contractor payments.

In the 1950's when hydrology and hydraulic modeling were needed to design watershed projects, SCS engineers provided leadership in computer modeling.

Water Quality

In the late 1980's, the Department of Agriculture and SCS developed policies involving water quality and quantity for both surface and ground water.

Environmental engineers and geologists initially provided leadership in addressing the issue. However, it was quickly recognized that the involvement of drainage and irrigation engineers was essential. As the program developed it became apparent that all of the engineering disciplines are needed in the planning, structure design, construction, and operation and maintenance. The key for the future is how to implement this program at the field level.

The 1985 Farm Bill

The 1985 Farm Bill included provisions that required farmers to develop plans to reduce erosion on highly erosive croplands and to protect existing wetlands.

Many professionals believed engineering staff involvement would be minimal because most work involved conservation planning, management practices, and followup. As implementation proceeded, it became obvious that low initial cost engineering practices were essential to the program and assistance from agricultural engineers and other engineering disciplines was needed. In addition, the wetland issue required accelerated engineering training of the staffs at the state, area, and field office levels.

performance without the danger of breaching. Consideration of the frequency of operation and stability evaluation for infrequent storm occurrence provided for a reasonable risk of maintenance level. The majority of the flood control dams constructed by SCS could not have been economically justified without dependence on earth spillways to convey large infrequent flows.

Drop inlets have been widely used by SCS for erosion control in cases where vegetative measures would not be effective. The "standard" design had an open vertical riser connected to a horizontal pipe or monolithic outlet. Some of these were found to be dangerous and a few reports of fatalities when people were being caught and washed through these structures

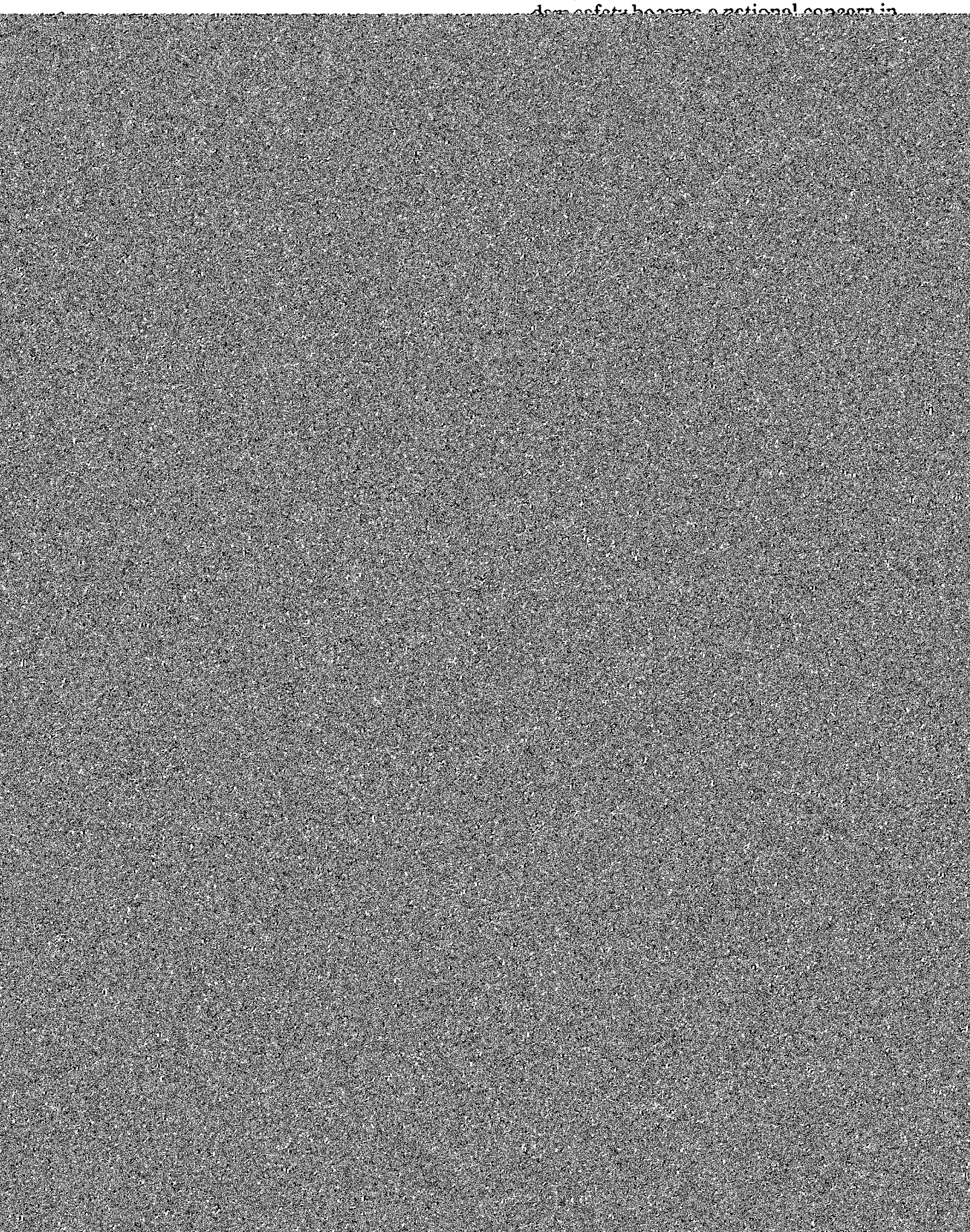
for conduits in SCS dams built on yielding foundations. Metal pipe manufacturers produced special appurtenances and fittings (inlet riser fittings, watertight couplers, antiseep collars, etc.) that were needed for certain classes of SCS dams.

The advent of computers in some respects revolutionized SCS design, in that it permitted consideration and evaluation of many more optional solutions and provided a means for rapid completion of the design. A catalog of standard drawings for structural components has provided a rapid source of construction drawings meeting common needs.

Construction

on the early works that were constructed by the farmers or local contractors hired by the farmers.

felt a responsibility to take an active role in promoting programs to insure the safety of downstream interests. When



Federal agencies agreed that this was a major problem and neededaction. Efforts were initiated by SCS to involve ASDSO with SCS state staffs in encouraging sponsors to update and test their EAP's. In addition, all sponsors of SCS-assisted projects were encouraged to develop and EAP for any high-hazard dam constructed prior to 1983.

At their 1989 annual conference in Albuquerque, the ASDSO presented the ASDSO National Award of Merit to Donald L. Basinger, Director, Engineering Division, SCS, for leadership in dam safety. The president of ASDSO stated,

> *through the SCS's successful national dam safety program and its work with ASDSO, dam safety in the United States is on the rise.*

SCS LEADERSHIP IN THE ENGINEERING PROFESSION

USDA-SCS has the responsibility for a national program for soil and water conservation. As priorities and programs change, engineers will continue to be vital to all soil and water conservation activities.

SCS engineers and geologists have continually exhibited leadership in their specialized fields and have maintained relationships with other professional organizations and societies to advance the technology and practice. Some examples are:

Consensus Standards

For many years SCS has developed standards and specifications for all the engineering conservation practices and has worked with various professional societies and commercial organizations to assure state-of-the-art practice. Each specification is updated often. Since 1964, SCS engineers have been in the lead and have directed the use of ASTM (American for all conservation practices that will be acceptable to all groups.

Technical Materials

SCS engineering handbooks, technical releases, and notes are being used worldwide. Many requests for these materials come from students and individuals, from libraries and other agencies, and from foreign governments and international offices. Traditionally, requests have come to and were filled by state offices, the Engineering Division, the Information Division or Central Supply. Because of the great demand for these materials, a change in the distribution system was necessary. Now most technical materials are sold by the National Technical Information Service in Springfield, VA. Some complimentary copies are provided by SCS offices as the circumstances dictate.

Currently the Engineering Division is participating with about 15 countries in an international effort with the Food and Agricultural Organization (FAO) of the United Nations (UN) to collect and

Sand and Gravel Filter Criteria

Over the years much has been learned about the mechanics of failure in earthfill dams. One of the most significant improvements in design has been the development of filter criteria to protect against all types of cracking and seepage

Spillway Studies

Because of the large number of dams designed and constructed by SCS, there are many emergency spillway discharge events from major storms over the nation. Many opportunities exist to study the damage resulting from vario

SOME PERSONAL OBSERVATIONS

One of the most attractive features to young engineers employed by the Soil

When research and operations personnel were closely associated, problems could immediately be addressed and priorities established. The close working relationship which

and handbooks to be noted. As a result, many technical developments conceived and perfected by SCS engineers have been rewritten and presented by others. With the passage of time, these other individuals become recognized for work that properly should have been credited to an SCS engineer or group. It is strongly recommended that reports of engineering techniques and processes developed by Service engineers carry acknowledgement for the individual or groups that participated in its preparation.

Maintaining qualified area engineering staffs is highly cost effective. This is especially true as the service is faced with implementation of programs such as RC&D, 1985 Farm Bill, and technical assistance on water quality and quantity, without additional field office staff. Much of the demand for complex technical engineering assistance to local units of government can most effectively be handled by engineers located at the area office level.

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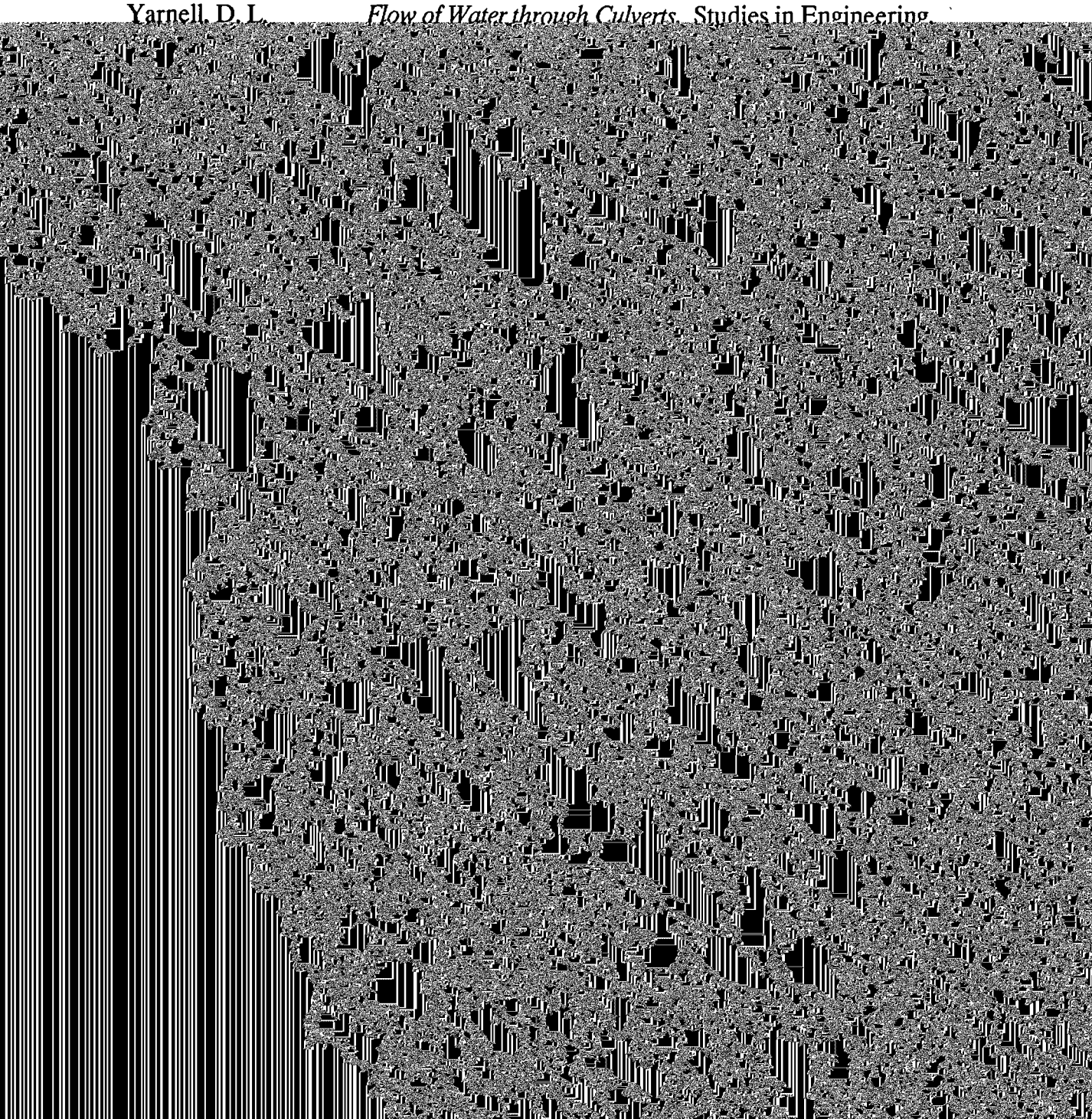

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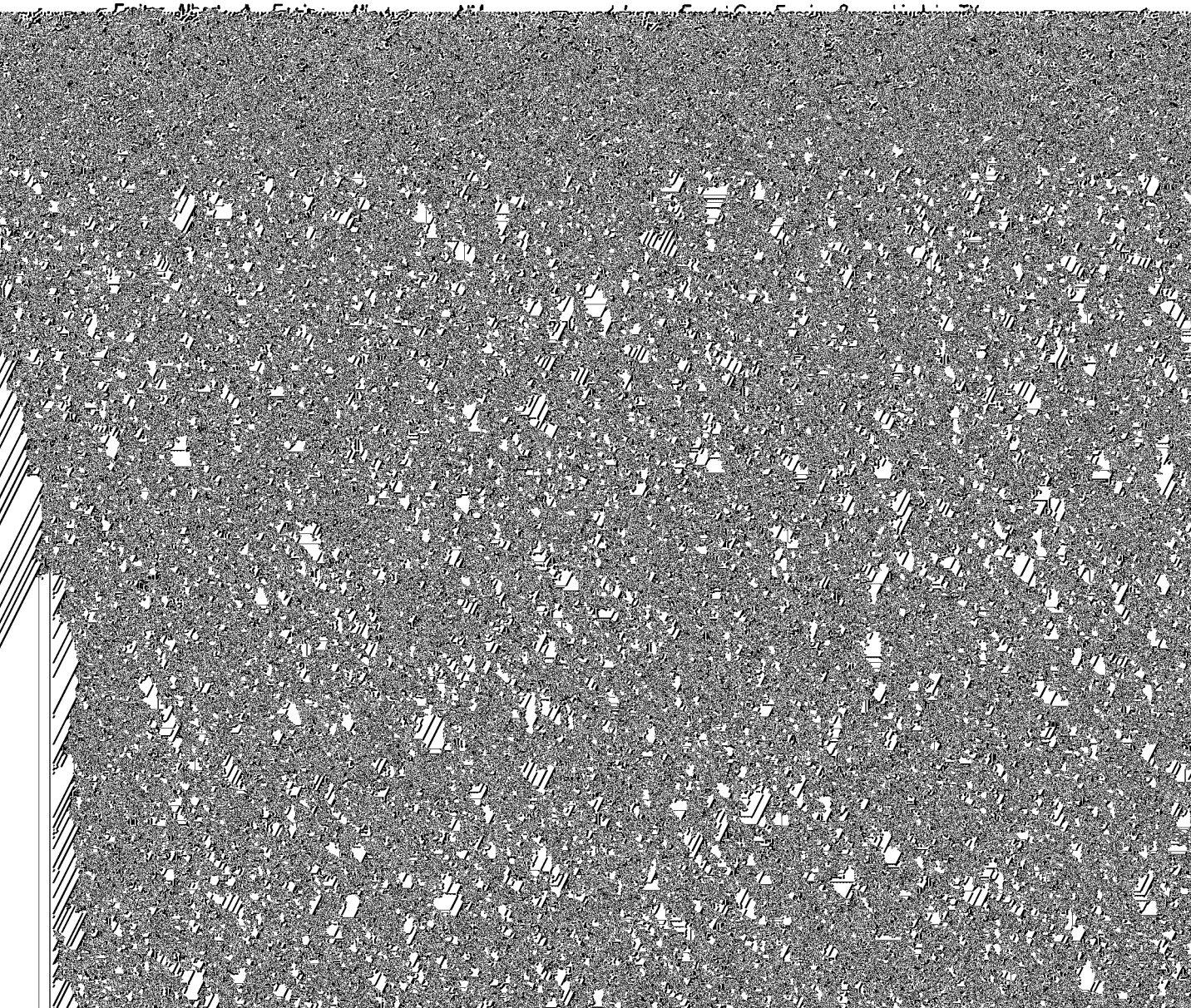

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